SOIL SURVEY OF THE FARGO AREA, NORTH DAKOTA.

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LOCATION AND BOUNDARIES OF THE AREA.

The Fargo area lies wholly within Cass County, N. Dak., one of the eastern tier of counties, and represents a typical section of the Red River Valley from the Red River on the east to the highest shore line of glacial Lake Agassiz on the west.

It is confined within meridians 96° 51′ 26″ and 97° 32′ 9″ west longitude and parallels 46° 47′ 33″ and 46° 57′ 47″ north latitude, and consists of townships 139 and 140, ranges 49 to 54 west, inclusive. There are 259,776 acres, or approximately 406 square miles, in the area.

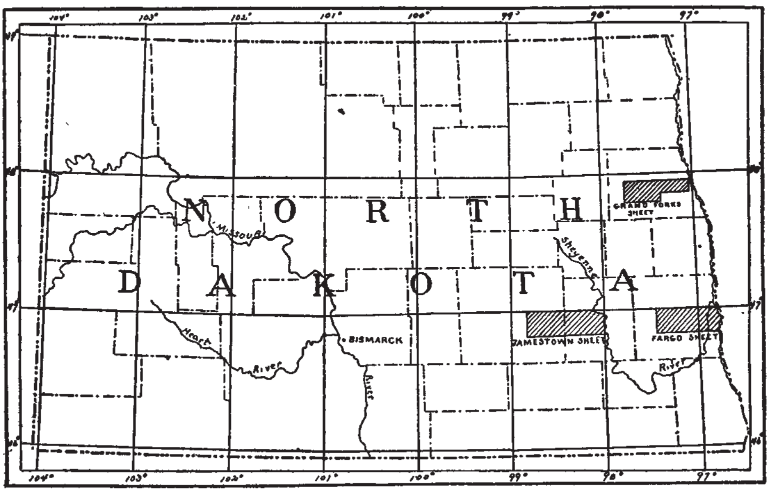

FIG. 49.—Sketch map showing location of the Fargo area, North Dakota.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first white settlement in the Red River Basin was as early as 1816, when the Selkirk Colony, coming via Hudson Bay, settled in the vicinity of Winnipeg. From that time until about the middle of the century fur trading was the only occupation of the white settlers of the region.

In 1851 a few white settlers obtained some land from the Sioux Indians for agricultural purposes, but the Indians were so troublesome that these early attempts at agriculture were unsuccessful.

It was not until late in the seventies, after the Northern Pacific and Great Northern railways had penetrated the region, that the special adaptation of the soil for wheat became generally known. From 1875 to 1885 the settlement of the region was pushed forward very rapidly, nearly all of the land in the valley being taken up during these years by homestead or preemption claims from the Government, or by purchase from railroad corporations of land which they had received from the Government as grants. Agricultural development was very rapid along the main lines of these railroads, and branches were soon built which greatly increased the shipping facilities of the area and resulted in a great impetus to farming. Many settlers flocked in from the older States and many came from the Old World, especially from Norway, Sweden, and Denmark. In 1889 Dakota Territory was divided, and two States, North Dakota and South Dakota, were admitted to the Union. During the last decade land values in the area have nearly doubled, and the prospects are for still higher values. During the last few years more stock has been introduced into the country, and there is a strong tendency toward more diversified farming and better cultural methods.

CLIMATE.

Owing to the absence of timber lands and the geographic position of the area in the center of a large continent and at a high latitude, the difference between the temperature of summer and winter is very great. Usually there are only a few days in summer when the mercury gets as high as 100° F., and the nights are always cool. The seasons are sharply defined. The growing season opens suddenly in April, when the surface of the ground thaws rapidly, permitting seeding in a few days. Winter is generally ushered in by a sudden cold wave in November, when the ground freezes and the fall plowing is stopped.

During the months of January and February the temperature is often from 10° F. to 30° F. below zero for days at a time, but owing to the dryness of the atmosphere this low temperature is not as difficult to endure as a much higher temperature along the coasts or lakes, where the humidity is usually greater.

The region may be classed as subhumid, the normal rainfall being about 23 inches. The table following, compiled from records of the Weather Bureau stations at Power and Wahpeton, N. Dak., and Moorhead, Minn. (across the river from Fargo, N. Dak.), shows the normal monthly and annual temperature and precipitation.

Normal monthly and annual temperature and precipitation.

Month.	Power.		Wahpeton.		Moorhead.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.
January	11.4	0.50	9.0	0.34	0.9	0.73
February	7.0	.60	9.4	.59	4.5	.83
March	19.0	1.59	24.0	2.63	20.2	.87
April	41.0	1.88	46.0	2.45	41.3	2.23
May	54.0	1.99	58.0	2.99	53.2	2.50
June	65.0	3.73	66.0	4.27	64.8	4.36
July	69.0	3.80	70.0	4.12	67.6	3.91
August	67.0	1.79	68.0	2.83	65.2	2.68
September	60.0	1.16	61.0	1.44	56.5	2.09
October	45.0	1.35	46.0	1.35	43.1	1.92
November	23.0	.61	26.0	.60	24.2	.92
December	13.0	.82	16.0	.35	11.9	.72
Year	39.5	19.82	41.6	23.96	37.6	23.77

A study of the records of temperature year by year seems to indicate that the winters are less severe than formerly, the greatest change being in January and February. In those months there has been a decided increase in temperature, while in March, April, and May the difference is less marked, and during the remainder of the year the conditions have been more constant. The milder winter is a fact well recognized by all farmers who have lived in the valley for a score or more of years.

Owing to the difficulty of getting onto the fields early enough in the spring to plow for seeding, nearly all of the plowing is done in the fall after harvest. This exposes the black soil characteristic of the valley to the sun during the winter months. The rainfall is greatest during June and July, the months when it is needed most by the growing crops. During January and February, the months in which there has been the greatest increase in temperature, the average precipitation is less than one inch. The small amount of snow that falls during these months is no longer lodged in the prairie grass as formerly, but is either blown off the plowed fields into the coulees or is melted upon the heat-absorbing black soil during the bright days. Before the country was broken up this snow was held in the prairie grass. A perfectly black body has the property of absorbing all radiations which fall upon it, and this increases its temperature. In the case of a black soil a part of the heat thus absorbed is again radiated, while a part of it is conducted away to other portions of the soil mass not exposed directly to radiation. The temperature of the soil, as a whole, is thus raised, and by radiation the soil warms the air to some extent. A perfectly reflecting body, on the other hand, which would in a way be approximated by the light-colored prairie grass and the white snow,

would reflect all the radiation falling upon it without any corresponding rise in temperature. This may account for the change in winter temperature thought to have taken place in this region.

The term "killing frost" represents a frost which will kill such crops as are generally grown in the valley, and usually represents a temperature of 26° F. If fruits or other more delicate crops were grown in the valley a higher temperature would have to be taken as indicating a killing frost. The average dates of killing frosts, based on records covering a period of twenty-two years, are as follows: Last in spring, May 14; first in fall, September 20.

PHYSIOGRAPHY AND GEOLOGY.

In preglacial times there was a broad, well-defined valley, cut through the soft Cretaceous shale, sloping northward from the vicinity of what is now Lake Traverse, S. Dak., past Winnipeg, Manitoba, to Hudson Bay.

During Glacial times the bottom of this valley became covered to a considerable thickness with glacial debris or till, and when the ice sheet retreated northward it became filled with water from the melting ice, and a lake was formed, with its southern end near Lake Traverse, and extending northward into Canada. This lake is known as Lake Agassiz. The width varied, but when the water was at its highest level the average width was about 45 miles. The great ice barrier to the northward would not permit the water to flow in that direction, and the natural drainage during this period was southward over the lowest rim of the basin and through Big Stone Lake.

The melting ice furnished an abundance of water, and rapid glacial streams carrying rock fragments of all sorts and sizes, as well as finer materials, deposited them in the bottom of this great lake. The material carried in by the streams was sorted by the action of water, the heavy sand and gravel being dropped in the shallow water along the shore, there to be reworked by the waves and piled up by them into beaches, and the finer materials, silt and clay, being carried in suspension and deposited in the deeper water.

When the climate became warm enough to lower the ice dam below the level of the southern outlet of the lake, the water again began flowing northward. The different beaches along the bottom of the old lake represent the different levels at which the water stood while the ice dam was being thawed away, and finally, when the ice was entirely removed, all but a portion, Lake Winnipeg, which was below the natural drainage channel, became dry.

This old lake bottom is now one of the most productive wheat-growing regions in the world, and is known as the Red River Valley, taking the name from the Red River of the North, which flows through

it northward into Lake Winnipeg and thence through the Nelson River into Hudson Bay.

The Red River Valley is remarkably level, having a continuous uniform slope northward of about 1 foot to the mile. The river itself flows along the lowest portion of the plain, and is very sluggish and meandering in its course. For the first 10 or 15 miles east and west from the stream the country rises imperceptibly, the average elevation being about 1 foot for every 5 miles.

The area surveyed comprises a typical section of the Red River Valley, extending from the Red River at Fargo westward beyond the highest shore line of the ancient lake. For the first 15 miles or so west at Fargo there is only about 3 feet difference in elevation. In the next 10 miles there is a gradual rise of about 8 feet to the mile. From Wheatland to the western edge of the area, a distance of 8 miles, there is a gradual rise of 22½ feet to the mile. From the Red River at Fargo westward to this point, a distance of 35 miles, there is a difference in elevation of 238 feet. Fargo has an altitude of 900 feet.

The highest shore line of the lake is represented by an abrupt beach which crosses the area at Magnolia in a northeast-southwest direction. The glacial till area to the westward is characterized by its rolling surface, made up of low hills, knolls, and kettle holes, and by the presence of rocks of all sizes strewn about the surface and disseminated through both soil and subsoil. This glacial till area passes under the lacustrine deposits to the eastward at a gentle angle. In several places in the western part of the lake area the knolls and hills of the underlying till come so close to the surface as to appear in the borings and along streams and in road cuts.

In places the distinct beach which passes through Wheatland appears to be made up largely of an escarpment of glacial till. At Casselton, 7 miles farther east, the underlying till is covered with the lake deposit to a depth of 70 feet. At Fargo the till lies more than 100 feet below the surface deposit of lacustrine silt and clay.

While the surface of the lowest portion of the valley is practically flat, there have been some marked changes since the original deposition. For example, the Red River and its tributaries, the Sheyenne and Maple rivers, have cut channels into the silt and clay, and during freshets have overflowed, building up the lands immediately adjoining, which now are higher than the country a few miles away. This higher ground, both because of its looser texture and its better condition as to drainage, is more satisfactory for farming than the lower ground. The deep black soil characteristic of the middle portion of the valley doubtless results from peculiar conditions once obtaining in this lower lying area, which for many years after the recession of the lake was an extensive marsh.

The rocks from which the soils of the valley were originally derived can be seen in the lake beaches, and consist largely of granite, gneiss, limestone, and, to a small extent, of Cretaceous shale. But the latter rock has entered into the composition of the soil to a much greater extent than would appear from its relative proportion in the beaches, for it is very soft and much more easily ground to a flour by the glacier than the harder granite, gneiss, and limestone. Chemical analyses of the water from the underlying Cretaceous shale and a field analysis of a piece of pulverized shale taken from a well show that it is quite alkaline. The fact that the alkaline rocks of the Cretaceous formation have entered largely into the composition of all the soils of the region accounts for the presence of alkali in all parts of the area.

SOILS.

Eight distinct types of soil were recognized and mapped in the Fargo area: The Marshall clay, Fargo clay, Miami black clay loam, Miami loam, Marshall gravelly loam, Marshall loam, Wheatland sand, and Wheatland sandy loam. The last-named type is unmodified glacial till; the other types are composed of the materials of this till sorted by water and more or less modified by weathering. The soils owe their distribution largely to the action of water, either of the glacial streams flowing into Lake Agassiz or of the lake itself. Thus, along the ancient shore is found a beach composed of coarse sand and gravel. Just east of this is found a sand classed and mapped as Wheatland sand. Toward the middle of the lake occur the soils classified as loams, clay loams, and clays.

The regularity of the separation, sorting, and deposition of the glacial till material was more or less interfered with by the fact that as the ice sheet retreated to the north the lake stood at lower levels. These levels are represented by several parallel beaches.

The area of the several soil types is given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall clay	76,800	29.6	Miami loam	11,968	4.6
Miami black clay loam	74,880	28.8	Marshall loam	7,168	2.7
Fargo clay	40,000	15.4	Marshall gravelly loam	2,688	1.0
Wheatland sand	29,504	11.4	Total	259,776	....
Wheatland sandy loam	16,768	6.5			

MARSHALL CLAY.

The soil of the Marshall clay is a jet-black clay loam or clay from 18 inches to 2 feet deep. The subsoil is a grayish-brown silty clay or

clay extending to a depth of 6 feet. From 6 to 9 feet the texture remains the same, but the color changes. When exposed to the air the subsoil breaks up into thin flakes resembling shale or slate.

This type occurs in large bodies in the eastern part of the area, principally between Maple River and Red River. The areas upon which it is found are a little higher than the Fargo clay or "gumbo" areas, but the differences in elevation are slight and the surface may be considered level. The condition of the Marshall clay has been greatly improved in recent years by the construction of ditches along the roads of every section line. The most desirable phase of this type is found along the rivers where the ground is a little higher and the drainage conditions are better. This type is purely a lacustrine deposit, but perhaps somewhat modified by the overflow of rivers subsequently to the time when it was laid down.

No injurious amounts of alkali were found in the first 3 feet of this soil, but the alkali increases in the lower depths and excessive amounts were often found in the sixth foot. Traces of bicarbonates and some sulphates were usually found in the surface foot.

The Marshall clay is recognized as one of the strongest soils of the area and as well adapted to wheat, oats, barley, flax, and corn. Because of its somewhat imperfect drainage it can not be seeded as early in the spring as can the lighter types to the westward, and consequently the crops mature later on this soil.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Marshall clay.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8451	NW. cor. sec. 24, Reed Tp.	Clay loam, 0 to 24 inches.	5.31	Tr.	4.04	6.50	11.80	11.50	39.28	27.10
8453	NE. cor. sec. 35, Barnes Tp.	Heavy clay loam, 0 to 24 inches.	5.48	.00	.54	1.36	6.80	10.92	49.38	30.66
8455	Fargo	Black clay loam, 0 to 30 inches.	5.79	.74	7.78	7.74	10.56	7.48	33.80	31.94
8452	Subsoil of 8451	Brown clay, 24 to 40 inches.	1.27	.00	.16	.30	2.38	4.20	57.00	36.00
8456	Subsoil of 8455	Clay, 30 to 72 inches.	Tr.	.00	.10	.20	1.10	2.20	38.06	58.26
8454	Subsoil of 8453	Gray clay, 24 to 40 inches.	Tr.	.00	.30	.40	1.60	2.12	36.50	58.76

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8452, 7.77 per cent; No. 8453, 1.20 per cent; No. 8454, 19.87 per cent; No. 8456, 14.58 per cent.

FARGO CLAY.

The Fargo clay consists of from 6 to 14 inches of heavy black clay, underlain by gray or blue clay of the same texture to a depth of 5 feet. From 5 to 9 feet it is composed of a mottled gray-brown and yellow clay identical with the corresponding section of Marshall clay. When wet this type is very waxy and gummy and has an oily feel. It is exceedingly slippery under foot and often sticks to the wagon wheels in such quantities that they present the appearance of mud disks. During the wet seasons it is a common sight to see great piles of this mud, or "gumbo" as it is called, along the roads, where the farmers have stopped to clean their wagon wheels. When dry this soil can not be turned by the plow, which either rides on the surface or pushes to one side or ahead of it cemented portions of the soil sometimes a yard across. When wet it is also difficult to cultivate, as it sticks to the plow.

The Fargo clay is found in all parts of the area from the Red River westward to Wheatland. It is not found west of this village, the soils there being lighter and the drainage more perfect. This type is always found in depressions, and, owing to the impervious nature of both soil and subsoil, water often stands upon the surface for weeks after a copious rain. The largest areas of the type are to be found between the Red and the Maple rivers in the vicinity of Fargo and Haggart, but small patches of it may be seen almost everywhere, associated with the heavier types of soil.

Alkali is always present in this soil, but usually not in injurious quantities. Except in a few isolated patches excessive amounts were not found in the first foot, but in the second and third feet the increase was usually quite marked. In nearly all cases the average for the first 3 feet was between 0.15 and 0.20 per cent. A few isolated spots, not large enough to be mapped on the scale used, were found where the average of the first 3 feet was as high as 0.40 per cent. If an average for the first 6 feet had been taken instead of for the first 3 feet nearly all the areas would show a salt content of about 0.40 per cent. The greater abundance of salts in the Fargo clay is the result of accumulation by leaching from higher lying lands. The peculiar waxy, gummy characteristic of the soil, it is suggested, may be due to the presence of small amounts of bicarbonates. The experiments of the college farm at Fargo show that by surface drainage, deep plowing, and turning under coarse manures these textural peculiarities can be considerably modified.

This soil is regarded as one of the strongest and most productive in the area when the season is favorable. The great difficulty is to get the seed in early enough in the spring and to keep the land from flooding and from baking after rains. Crops are often injured as much by the baking of the soil after a rain as by a flood. Under the

present imperfect condition of drainage, it is only about one year in five that the season is such as to give the best crops from this type. As a result these lands are held in low esteem for general farming. When seeded with brome grass, or covered with natural prairie grass, they are excellent for hay and pasture.

The following table shows the texture of the soil and subsoil of this type as determined by mechanical analysis:

Mechanical analyses of Fargo clay.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8464	SE. cor. sec. 2, Gill Tp.	Clay, 0 to 12 inches..	3.63	0.20	1.30	1.10	4.00	9.50	37.82	46.00
8458	N. cen. sec. 5, Everest Tp.	Black clay, 0 to 12 inches.	2.66	.12	.60	.80	3.40	6.70	34.48	53.90
8465	Subsoil of 8464......	Clay, waxy when wet, 12 to 24 inches.	1.58	Tr.	.70	.70	2.08	5.80	27.00	63.36
8459	Subsoil of 8458......	Waxy, impervious clay, 12 to 24 inches.	2.22	.00	.26	.46	1.08	4.10	25.02	68.86

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8458, 3.37 per cent; No. 8459, 2.59 per cent.

MIAMI BLACK CLAY LOAM.

The surface soil of the Miami black clay loam consists of about 14 inches of heavy gray or black loam, lighter in texture than the material of the Marshall clay. This is underlain by a silty clay loam to a depth of 36 inches, beneath which occurs a chalk-colored material, slightly coarser in texture, and reaching to a depth of 6 feet. In the lower depths this light-colored material becomes yellowish owing to the presence of iron oxide. Small beds of gypsum often occur in the second foot.

This soil type is found in a large, continuous body which extends across the area in a northeast-southwest direction from the vicinity of Maple River westward nearly to Wheatland. From the extreme eastern limit to the extreme western limit of the type there is a difference in elevation of nearly 60 feet. This gives a gradual rise of about 6 feet to the mile, so that the drainage conditions are more favorable than in any of the types to the eastward. Because of this and of the more porous nature of the subsoil, water seldom stands upon the surface long enough to cause injury to growing crops or to retard cultivation. This soil retains moisture well and gives it up in time of

drought when the growing crops most need it. The soil is typically developed in the regions north and south of Casselton.

To a depth of 3 feet there are no injurious amounts of alkali in either soil or subsoil. Below that depth the amount sometimes becomes considerable. A trace of black alkali was found in the surface foot.

The Miami black clay loam is the soil which has contributed most to the fame of the Red River Valley as a wheat-growing district. As developed in this area, it seems especially well adapted to this crop, although in the Central West it is considered a typical corn soil, much less desirable for wheat than some of the prairie types. The rigorous climate of the Red River Valley is less suited to the production of corn than of wheat, and this fact has tended to limit the use of the Miami black clay loam to wheat production.

The extensive development of the Miami black clay loam in the valley, its generally smooth surface and good drainage, all favor the most extensive methods of farming, and there are probably no wheat farms in the world larger than those found in the Red River Valley.

The production of corn on this type is increasing, and it is thought that ultimately an early-ripening variety will be established and the risk of damage from freezing reduced to such a degree that corn will form an important crop of the area. Large yields of Irish potatoes can be produced on this type, but this crop is at present grown only for home consumption.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Miami black clay loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8298	S. cen. sec. 35, Casselton Tp.	Brown loam, 0 to 14 inches.	4.03	0.14	0.40	0.70	2.44	13.86	67.76	14.68
8422	Sec. 1, Harmony Tp.	Brown loose loam, 0 to 20 inches.	4.69	.00	.90	.52	4.20	40.56	36.58	17.20
8425	Sec. 34, Everest Tp.	Brown loam, 0 to 15 inches.	3.39	.30	.88	.78	1.88	30.90	34.54	30.54
8423	Subsoil of 8422......	Gray loam, 20 to 36 inches.	4.81	.00	.40	.50	1.78	34.60	39.26	23.30
8299	Subsoil of 8298......	Gray clay loam, 14 to 36 inches.	Tr.	.18	.16	.24	.86	7.92	64.50	25.80
8426	Subsoil of 8425......	Loam, 15 to 36 inches.	Tr.	Tr.	.62	.46	1.36	21.86	42.56	32.90

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8298, 3.58 per cent; No. 8299, 18.63 per cent; No. 8423, 8.01 per cent; No. 8426, 20.15 per cent.

MIAMI LOAM.

The Miami loam is composed of about 20 inches of heavy, rich dark-brown loam, somewhat similar in texture to the surface material of the Miami black clay loam, grading without a perceptible change of texture into a grayish-yellow clay loam or clay. Below the third foot the soil retains the yellowish color, and sometimes becomes a trifle sandy. Iron oxides are often present in the lower depths and crystalline gypsum is frequently found in the second and third foot.

This type includes an area from 1½ to 2 miles wide, extending in a northeast-southwest direction along the eastern border of the distinct beach which passes through Wheatland. It is bordered on the east by the Miami black clay loam. The area covered by this type slopes gently toward the east, the inclination being sufficient to insure good drainage. This fact, together with the richness of the soil and its somewhat porous nature, makes it one of the most desirable types in the Red River Valley. It can be seeded or planted irrespective of wet weather, and the porous nature of the soil allows the moisture below to rise by capillarity in times of drought.

With the exception of a few spots, this type carries less than the minimum, 0.20 per cent, of alkali in the first 3 feet. The alkali content increases in the lower depths, but is not high enough to injure plants in any of the first 6 feet. The few spots where the injurious salts are found in excess are close to the sand beach forming the western boundary of the type, and seem to be due to saline springs which ooze out of the sand and gravel. With the exception of a narrow strip in secs. 3 and 10, Gill Township, these areas were not large enough to be shown on a map of the scale used. They usually range from a few square rods to 2 acres in extent.

The typical areas of the soil are well adapted to wheat, oats, barley, corn, millet, and flax. During dry seasons the crops suffer to some extent from the effects of alkali.

The following table shows the texture of the soil and subsoil of this type:

Mechanical analyses of Miami loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8434	S. cen. sec. 6, Casselton Tp.	Brown loam, 0 to 14 inches.	6.75	3.50	7.84	4.74	18.76	25.86	26.60	12.66
8436	S. cen. sec. 13, Wheatland Tp.	Brown loam, 0 to 15 inches.	6.35	.00	2.80	5.50	21.00	19.96	29.92	20.86
8438	Middle of sec. 15, Gill Tp.	Brown loam, 0 to 20 inches.	5.56	Tr.	1.44	2.00	15.10	24.70	35.78	20.92
8435	Subsoil of 8434......	Brown clay loam, 14 to 36 inches.	1.42	7.60	9.18	4.38	13.68	18.68	22.20	24.06
8437	Subsoil of 8436......	Clay loam, 15 to 36 inches.	Tr.	1.00	2.80	2.60	9.30	9.40	25.48	48.80
8439	Subsoil of 8438......	Yellow clay, 20 to 36 inches.	.83	.00	.74	.72	5.18	12.48	25.90	54.76

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8435, 14.57 per cent; No. 8437, 8.81 per cent; No. 8439, 9.02 per cent.

MARSHALL GRAVELLY LOAM.

The Marshall gravelly loam is composed of about 12 inches of heavy black sandy loam, underlain by 2 feet of coarse gravel resting on a coarse sand extending to a depth of 6 feet or more. The most abundant rock constituent of the gravel is limestone. There are also present considerable quantities of granite and other crystalline rock fragments, and a few fragments of Cretaceous shale.

The type represents beaches formed during the recession of glacial Lake Agassiz. These beaches cross the area in fairly well defined lines in a northeast-southwest direction. In places they are broken down or obliterated, while in other places they appear like escarpments of glacial till modified by the action of water. In some places there are considerable quantities of large glacial bowlders strewn over the surface, but these are not numerous enough seriously to interfere with cultivation, and in most areas they have been gathered into piles. Where the railroads cut these beaches, large quantities of sand and gravel have been taken out for use along the tracks. The materials are also used throughout the country for building purposes.

Except in very wet seasons the crop yields on this type are very light, owing to the excessive drainage resulting from the gravelly nature of the subsoil. The areas occupied by this type are narrow, usually no more than 60 rods wide.

The following table gives the mechanical analyses of typical samples of fine earth of this soil:

Mechanical analyses of Marshall gravelly loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8446	SW. cor. sec. 6, Casselton Tp.	Brown, heavy, sandy loam, 0 to 14 inches.	6.87	4.50	14.22	12.72	18.22	17.60	20.52	11.28
8449	N. cen. sec. 3, Gill Tp.	Brown, sandy loam, 0 to 14 inches.	5.65	5.50	13.34	9.04	15.26	9.86	27.16	19.76
8447	Subsoil of 8446....	Coarse gravel, 14 to 36 inches.	.43	12.16	28.56	27.76	24.46	1.76	1.96	3.12
8450	Subsoil of 8449....	Coarse gravel and sand, 14 to 36 inches.	.74	6.00	16.46	13.76	48.66	4.98	4.70	5.34

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8447, 4.18 per cent; No. 8450, 5.14 per cent.

MARSHALL LOAM.

The soil of the Marshall loam consists of a dark-colored loam which grades into grayish-brown loam at about 8 inches below the surface. This is underlain by a gray silt or clay loam or clay containing some grit and reaching to a depth of 4 feet. Below the fourth foot the texture remains the same, but the color changes from grayish to yellowish. Below the second foot the materials are very similar to those occupying the corresponding section of Miami black clay loam.

This soil occupies the plateau area, extending in a northeast-southwest direction, in a body about 2 miles wide, across Wheatland and Gill townships. It is bounded on the east by an ancient beach and on the west by the gently rising area occupied by the sandier type of soil, the Wheatland sand. Some of it is in a slight depression, but the porosity of the subsoil and the good natural drainage make it desirable for all farm crops. It is a little more subject to drought than the Miami loam. The chief distinctions between the Marshall loam and the Miami loam are that the latter has a deeper soil and is not so subject to drought. The crops yield a little better also, and altogether the Miami loam is recognized as the more desirable type. Along the western edge of the Marshall loam area, where it comes in contact with the Wheatland sand, there are several patches of ground, usually not more than a few square rods or at most a few acres in extent, upon which oats, wheat, corn, flax, and other crops, after germinating and

beginning an apparently healthy growth, are soon dwarfed and killed, while the closely adjoining crops present a healthy and vigorous appearance and on maturing give a satisfactory harvest. These spots are usually moist, and in dry weather a considerable crust of alkali can be seen. They are in the lower places and where the underlying glacial till is only a short distance below the surface, and are caused by the rise of the alkaline waters from the glacial till and the accumulation of the salts on the surface by evaporation. A field analysis of the soils in these spots shows that the chlorides predominate, but that considerable quantities of sulphates and some bicarbonates are also present.

This soil owes its origin partly to the transportation of fine sand from the higher lying Wheatland sand to the westward and partly to the overwash of the beach to the eastward during recession of the glacial lake. A little crystalline gypsum is found in some of the areas, usually not far beneath the surface, while at lower depths iron oxides are usually present.

The Marshall loam is recognized as a good, safe soil, regardless of wet or dry seasons. It is a better soil for all farm crops than any type in the area farther west, but the yields are not quite as large as on such types as the Miami loam and the Miami black clay loam, which have heavier subsoils. On the other hand, it is more easily worked. It is well adapted to wheat, oats, barley, corn, flax, Irish potatoes, and truck crops.

The following table gives the mechanical analyses of typical samples of this soil:

Mechanical analyses of Marshall loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8428	E. cen. sec. 4, Gill Tp.	Brown loam, 0 to 18 inches.	4.70	0.52	1.70	2.04	11.24	26.96	39.16	17.88
8432	E. cen. sec. 17, Gill Tp.	Brown loam, 0 to 24 inches.	5.29	.80	2.70	2.60	12.20	22.22	41.04	18.28
8430	N. cen. sec. 34, Wheatland Tp.	Heavy loam, 18 to 36 inches.	7.19	.90	3.70	4.30	13.84	16.70	37.60	22.96
8433	Subsoil of 8432......	Brown clay loam, 24 to 36 inches.	5.14	.80	2.28	2.70	9.60	16.20	35.08	33.06
8429	Subsoil of 8428......	Light clay loam, 18 to 36 inches.	1.18	Tr.	.80	.84	5.00	21.70	36.52	34.80
8431	Subsoil of 8430......	Gray clay, 18 to 36 inches.	1.01	1.10	1.92	1.92	4.90	6.86	42.70	40.60

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$); No. 8429, 35.97 per cent; No. 8430, 1.02 per cent; No. 8431, 21.59 per cent; No. 8433, 7.39 per cent.

WHEATLAND SAND.

The Wheatland sand is composed of from 12 to 18 inches of a medium fine dark-brown sand, which is underlain by grayish-yellow sand of the same texture to a depth of 3 feet. Below this depth the sand becomes coarser and yellower. At about 6 feet the material is often a clay loam of grayish-yellow color, containing a considerable quantity of iron oxides. The underlying glacial till is often reached in deep borings.

This soil occupies an area from 3 to 4 miles wide, extending across the area in a northeast-southwest direction through Wheatland, Gill, and Howes townships. It is bounded on the west by the extreme eastern limit of the shore of glacial Lake Agassiz and on the east by areas of the Miami and Marshall loams. From the eastern to the western edge of this area there is a rise of about 100 feet, so that, with the exception of two narrow strips along the old lake shore, extending across sections 11 and 14 in Howes Township, the entire area is well drained. These two low, marshy places, which are a little below the natural avenues of drainage, are covered with water until late in the season, but furnish excellent pasture and hay meadows. In both of these marshes the soil and subsoil are of a more silty nature than in the rest of the type.

The Wheatland sand was formed by wave action, in shallow water, during the recession of the ancient lake. Throughout the type are several low beaches, often only a few feet high, and upon the crests of these beaches the soil is usually too loose and sandy to be of value under the present conditions of agriculture. This type is the lightest soil in the Fargo area and needs much rain to insure fairly good crops. The crops are sometimes blown out by strong winds.

With the exception of some limited areas along the eastern border of this soil, it is freer from alkali than any of the other soils. The limited areas already mentioned are closely associated with the alkali spots referred to in the description of the Marshall loam, and are confined to the lowest portions of sections 28, 32, and 33, Wheatland Township. A field analysis of soil from these spots showed that they contain injurious quantities of both bicarbonates and chlorides.

In growing wheat this soil usually produces a good growth of straw, but the plants do not head well and the yield is light. It is well adapted to pasture and grazing.

The following table shows the texture of typical samples of fine earth of this soil:

Mechanical analyses of Wheatland sand.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8476	Sec. 17, Wheatland Tp.	Brown sandy loam, 0 to 18 inches.	2.27	0.90	3.48	5.50	47.20	23.38	12.08	7.46
8478	Sec. 24, Howes Tp.	Sandy loam, 0 to 18 inches.	2.55	.80	3.08	5.36	49.58	21.98	11.52	7.46
8477	Subsoil of 8476....	Gravelly loam, 18 to 40 inches.	.92	17.20	10.30	5.18	29.90	13.50	12.78	11.04
8479	Subsoil of 8478....	Gravelly loam, 18 to 40 inches.	1.50	12.90	9.56	5.46	23.38	15.48	12.00	11.06

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8477, 10.30 per cent; No. 8479, 7.93 per cent.

WHEATLAND SANDY LOAM.

The Wheatland sandy loam is composed of about 14 inches of dark-brown sandy loam, underlain by a loam which at a depth of 6 feet or more rests upon a grayish-yellow or yellow glacial till. Throughout the subsoil occur small rock fragments, varying from the size of a pea to that of an egg. In the second and third feet gypsum often occurs, and in lower depths concretions of iron oxide are usually present. Often the surface is strewn with gravel, especially on the crests of the prairie swells. Glacial bowlders of limestone, granite, gneiss, and schist are abundant in places, though not usually in sufficient quantities to interfere with cultivation.

This type is found in the extreme western part of the area outside the limits of the territory once covered by Lake Agassiz. It extends westward past Buffalo, where the surface becomes more undulating. There is a gradual rise of about 20 feet to the mile toward the west, and the drainage is better than elsewhere in the area. In places there are many swales and kettle holes, with knolls and hills rising above them. Some of these places are filled with water the year round; others have a thick deposit of muck. None, however, were large enough to be shown in a map of the scale used, most of them being only an acre or two in extent.

No injurious amounts of alkali were found in either soil or subsoil to a depth of 3 feet, but several 6-foot and 9-foot borings were made, and in these lower depths the alkali is sometimes found in considerable quantities. A few low spots contain so much alkali that nothing will grow, but these spots are usually not more than 1 or 2 rods across.

When the dry season is not too long the Wheatland sandy loam is a fairly desirable soil for general farming, as both soil and subsoil are of such a texture as to retain moisture well and to supply it to growing crops in time of drought. The soil varies according to location. On the crests of the prairie swells it is somewhat more sandy and gravelly than in the depressions, where the texture is decidedly more loamy. The soil in the lower places is regarded as more desirable when the season is not too wet.

This type is made up wholly of glacial till, and is esteemed a stronger and safer soil than the Wheatland sand. But, like the latter, considerable of it is still unbroken, and is used only for the production of wild hay and as pasture. This type produces fair crops of wheat, oats, flax, barley, and corn. In the more loamy places it is found to be remarkably well adapted to Irish potatoes and other root crops.

The following table shows the texture of the fine earth of soil and subsoil as determined by mechanical analysis:

Mechanical analyses of Wheatland sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8440	NE. cor. sec. 10, Buffalo Tp.	Brown sandy loam, 0 to 15 inches.	6.31	2.50	4.40	4.10	17.52	19.46	35.16	16.96
8444	NE. cor. sec. 21, Howes Tp.	Brown sandy loam, 0 to 14 inches.	6.98	1.50	4.46	4.94	19.00	20.74	28.88	20.48
8442	NE. cor. sec. 34, Buffalo Tp.	Brown sandy loam, 0 to 12 inches.	4.87	1.20	4.16	4.66	16.50	20.38	30.70	22.00
8441	Subsoil of 8440	Yellow sandy loam, 15 to 36 inches.	1.02	2.08	4.54	4.02	16.94	20.66	32.14	19.30
8445	Subsoil of 8444	Yellow loam, 14 to 36 inches.	Tr.	2.24	5.10	5.76	20.38	19.18	19.78	27.00
8443	Subsoil of 8442	Yellow loam, 12 to 40 inches.	1.54	2.50	6.10	5.30	15.98	18.68	22.50	28.40

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 8440, 2.17 per cent; No. 8441, 13.53 per cent; No. 8442, 4.35 per cent; No. 8443, 23.54 per cent; No. 8444, 7.11 per cent; No. 8445, 22.68 per cent.

DRAINAGE.

The most important problem in the Red River Valley, and the one in which the farmers are taking the keenest interest, is the problem of drainage. Westward from the Red River to the Maple River, in a distance of 15 miles there is only a difference of 3 feet in elevation. There are approximately 25,000 acres of land in this area upon which the water from the melting snow often does not run off or soak into the ground soon enough to permit seeding at the proper time in the

spring. The subsoil is heavy, gummy, and impervious to water. This, together with the fact that the frost line is from 5 to 8 feet below the surface, would make underdrainage very difficult, if not impossible. Some farmers "mud in" their crops; others are not able to do even this, the land being so soft that it is unsafe to put teams on it. "Mudding in" crops is very unsatisfactory, because after it is done the ground bakes so hard that a great deal of the seed never comes up, or is "choked off" after it does come up.

In seeding time after a copious rain all farm operations have to be postponed from a week to ten days, while the water gradually soaks into the ground or slowly drains off. The seriousness of all this is more fully realized when one takes into account the shortness of the growing season in North Dakota, and also when one sees the disastrous effects of standing water upon growing crops. In the area under discussion, under the present imperfect conditions of drainage, it is only about one year in five that paying crops are harvested. It should be kept in mind that these wet areas, indicated on the soil map as the Fargo clay, are not altogether unproductive, but under favorable conditions produce the largest yields of grain of any soil type in the Red River Valley. But the uncertainty of yield has led to the abandonment of these lands by most of the original owners, and at present it is often impossible even to find tenants willing to cultivate them. The few houses in this region are tumbling down, the yards are growing up to weeds, and the general appearance of things is in marked contrast with the prosperous appearance of the farms on the adjacent higher lying and better drained areas, indicated on the soil map as the Marshall clay. An unfortunate feature is that these lands are upon the market for speculative purposes, and are quoted as high as the best lands adjoining. The unacquainted buyer who comes into the country with an honest intention of making it his home is often deceived, being led to believe that all Red River Valley land is the same.

There are several causes for the present unfavorable condition of drainage in the Red River Valley, the principal ones being the levelness of the country and the lack of fall in the Red River itself. It should be kept in mind, too, that the river flows north, and consequently the difference in time when the ice breaks up in its lower and its upper courses tends to hold the water back. Another thing which checks the flow of the stream is the crookedness of its channel. As a result, the river rises, backs up its tributaries, and frequently the latter overflow their banks and flood the fields.

Obviously, man can not regulate the periods at which the ice breaks up in the lower and upper courses of the Red River, nor would it be practicable to attempt to deepen the channel; but enough remains to be done to greatly improve the present conditions, and the fertility and importance of the region to be benefited warrants the expenditure

of a large sum of money. For example, where the channel is so crooked and meandering as to retard the river's flow, it could be straightened so as to give the water a free course. Another important move in the control of the river, and one which has been under consideration for some time, is the construction of a storage reservoir in its upper course. During the spring freshets, and until after the ice had broken up along the international boundary line and beyond, this could be used to retain the water, which could then be let off gradually.

The most practical scheme, however, and the one which would be of immediate and probably of permanent relief, would be the construction of deep canals from the rivers to the undrained areas. In this matter the consideration of most vital importance is whether the fall between the undrained areas and the rivers is sufficient to carry off the water in case canals are constructed. From observations made during the survey and from an examination of the records of previous years' floods the conclusion is that such a scheme is entirely feasible. The main reason why drainage by this means has not been successfully established in the past is that it is too big an undertaking for private persons and needs State or National aid.

The records of the stages of the Red River at Fargo show that during the month of April the mean height of the river is approximately 30 feet below the level of the prairie. The undrained areas are from 2 to 4 miles west of the river, so that this would give a fall of from 7 to 10 feet per mile. It is believed that this is sufficient provided the canal were about 25 feet wide and 15 feet deep. In this connection it might be well to state that the water table in this part of the Red River Valley is about 22 feet below the surface, so that there is no danger of encountering it in a 15-foot canal. Along the Sheyenne River, in the vicinity of Haggart, the conditions at first sight do not seem so favorable, because the mean height of the river during the month of April is only about 8 feet below the level of the prairie, but as the undrained area east and west of the river is only from 1 to 2 miles off, this gives nearly as great an average fall per mile as in the area near the Red River. A canal dug from the Sheyenne at Haggart directly west for 3 miles to the large coulée would not only drain the wet area directly west of the river, but by deepening the coulee which goes southwest into Durbin Township the large wet area in the vicinity of Durbin would also be drained.

The chief purpose of these canals would not be to carry off the water of spring freshets, but to furnish a ready outlet for the water which accumulates in these low places after heavy rains. In the higher lying areas, indicated on the soil map as the Fargo clay, there is a road along every section line and a ditch on each side of the roads. After a heavy rain the water of these areas finds a ready outlet through the ditches, and often this water accumulates in the lower areas, convert-

ing them into sheets of water and drowning out the crops. By the construction of canals the waters of the higher areas would be afforded a direct course to the rivers. Then by the construction of roads and ditches along all the section lines of the low, wet areas the rain water would have a free course through the ditches and canals into the rivers also. It has been demonstrated by the experiments on the college farm at Fargo that the first requisite in reclaiming the low, wet lands is drainage, and that then by deep plowing and careful methods of cultivation the "gumbo" properties of this soil gradually disappear.

ALKALI IN SOILS.

All the soils of the area contain some alkali either in the soil, the subsoil, or in still lower depths. The "gumbo" areas and an area of low, sandy country west of Wheatland, occupied by the Wheatland sand and the Marshall loam, are the only areas which contain injurious amounts of alkali in the first 3 feet.

It was found that in the "gumbo" or Fargo clay areas the surface foot was comparatively free from alkali, while in the sandy area, referred to above, the injurious alkali was either upon or near the surface. This was found to be due to the fact that in the case of "gumbo" there is no percolation upward of soil moisture because the soil is too impervious, and hence there could be no concentration near the surface by evaporation. In dry weather the surface of the heavy soil bakes and cracks up into irregular pieces. In the case of the sandy area the water table is only from 6 to 15 feet below the surface; sufficiently near for capillary forces to bring the underground water to the surface. The worst alkali conditions were found where the water table was nearest the surface and where the soil was also sandy and porous. Wells in this vicinity are commonly so alkaline that the water can not be used for drinking purposes.

Fair crops were seen growing upon the Fargo clay when the average for the first 3 feet was as high as 0.35 per cent alkali, but with the greater amounts in the second and third feet, while in the sandy area west of Wheatland the grain was killed when the average for the first 3 feet was only 0.20 per cent alkali, but with a concentration in the first 2 or 3 inches.

Injury from alkali is very largely a matter of seasons. If it happens to be wet at seeding time and continues so until the crops get a good start there is apparently no injury. On the same piece of ground the crops may be entirely killed the next year if the soil is very dry at seeding time and the alkali is concentrated near the surface.

In the case of the Marshall clay the alkali content gradually increased downward to 6 feet, with apparently no concentration in any particular foot section, while in the case of the sandy soils west of Wheatland the alkali content decreased until there was often

almost none at 9 feet. No borings were made deeper than 9 feet. In the higher lying areas of the Wheatland sand, where the water table was far below the surface, the soil was often free from alkali, and only a very little was found in the lower depths of the subsoil. In all other types in the area the alkali content invariably increased in the deeper subsoil.

There seems to be no relation between the proportion of alkali in the soils and in the water of wells, except when the soils are very porous, as in the case of the Wheatland sand, and the water table is only a few feet below the surface.

Along the foot of the old beach which passes through Wheatland there are several small spots which are so badly alkaline that the crops usually "burn out." Only one of these spots was large enough to map on the scale used. These spots are the result of the seepage from alkali springs at the bottom of the old beach.

Under the present methods of farming, where land is so plentiful and where everything is done on such a large scale, the alkali will never be a serious problem. Nothing has ever been done to remove it, and very little is said or thought about it. The all-important question over most of the area, and the question which is being seriously considered, is how to drain the low, flat lands in the vicinity of the Sheyenne and Red rivers.

AGRICULTURAL METHODS.

The early settlers of the Red River Valley were surrounded by conditions very different from those in almost any other part of the country. There were no rocks to be removed and no forests to be cleared. The settler had simply to build his sod house and barn, turn up the rich, level prairie soil, and sow his seed.

When the special adaptation of the valley for wheat became known the region leaped into prosperity, and the land values—a few dollars an acre a generation ago—have steadily increased to an average of $35 an acre at the present time. No other portion of the country could compete in wheat production with this region, because of the cheapness with which this crop could be produced and the vast scale upon which it was grown. The gradual extension of the wheat-growing region to other portions of the Northwest and the lower Canadian Provinces has made the supply greater and the prices lower. The continual growing of wheat for twenty years has in most places decreased the yield from the soil about one-half. These conditions are forcing the farmers of the region to adopt better methods.

Since its introduction flax has been one of the most profitable crops in the area, and especially so upon new land. It has been so profitable that farmers have been known to pay for their farms with profits from two crops. During the past few years, however, the crop has been

seriously affected by a fungous disease popularly known as "flax wilt." The disease has been studied at the experiment station at Fargo, and the experiments, together with a study of the conditions in other flax-growing countries, show that the plant can not be profitably produced year after year upon the same land.

The spread of the disease to new lands can be avoided by the selection of healthy seed and by the treatment of all seed with a solution of formaldehyde. As yet no method has been found to do away with the fungi after the soil has been infected. In Russia and Belgium, where the plant is extensively grown, a period of from seven to twelve years is necessary between the crops if this disease is to be avoided. Crops in closer succession become wholly worthless on account of the disease.

A considerable revenue is now obtained from the sale of flax straw, where formerly it was burned after thrashing. The farmers haul the straw to the mill at Amenia, or at Fargo, where it brings $2 a ton. It is drawn to market in the winter when the roads are hard and at a time when farmers have little else to do. The mills dispose of their product in the East, where it is used largely in the manufacture of paper.

During the last two or three years macaroni wheat has been grown to some extent; and, although the price is lower than that for the standard varieties grown in the area, the fact that the yield is about one-third larger is making the variety popular.

On the loamy types of soil where the drainage conditions are favorable Irish potatoes do remarkably well, sometimes yielding as high as 200 bushels per acre. As yet they are grown only to supply local markets, though a few shipments have been made to the Southern States for use as seed.

The climate and soil are well fitted to the production of nearly all kinds of late vegetables. Celery does very well, and, judging from a few sugar beets grown in gardens, it would seem that there is a good opportunity for the introduction of that industry.

Strawberries, gooseberries, raspberries, and currants, provided they are sheltered from the winds by hedges of golden Russian willow, Norway spruce, soft maple, poplar, or in fact any kind of tree that will endure the climate, can be profitably produced. There is no one thing which is needed more or which would be of more value to the area than trees. Along the Sheyenne River in the vicinity of Haggart, where there are many large native trees, the weather in winter is much milder. In the midst of these trees a few apples and plums are being successfully grown, largely because the young trees are protected from the cold winds and the blossoms are not blown off in the spring.

Corn has been introduced and acclimated to the short-growing sea-

son, and is now one of the important crops of the area. It is usually rotated with wheat, the latter producing greater yields and being freer from weeds if sown after the cultivated crop of corn.

Throughout the area there is a general lack of care in plowing and in preparing the seed bed. Plowing is usually very shallow, and this has decreased the productiveness of the soil. The practice of plowing a little deeper every third or fourth year, and bringing up an inch or so of the new soil to the surface to be acted upon by the weather and soil bacteria, is the most satisfactory method. It is best to plow in the fall and harrow immediately, so as to fill up the large air spaces and prevent the furrow splice from drying out. If this is done, the soil will settle down sufficiently during the winter and spring months to establish good capillary connection with the subsoil.

No commercial fertilizer has ever been used in the area, and heretofore the opinion has prevailed that barnyard manure was more injurious than beneficial to crops. Where coarse manures are turned under they often have a tendency to make the soil too dry. When well-rotted manures were turned under they often had a tendency to make the growth of straw so large that it would lodge before harvesting. During the last few years, however, it is found that crops are greatly benefited if well-rotted manure is spread on the plowed ground in the fall and allowed to remain there all winter. It is often advisable to rake up and burn the coarse litter in the spring at seeding time. A great deal of manure in the area is still wasted, as formerly, by being dumped into the sloughs or drawn out in piles and burned.

AGRICULTURAL CONDITIONS.

The chief resources of the area are found in its very productive soil, especially as adapted to the production of grain. On the better types of soil and where the farmers have paid attention to business most of them have become independently wealthy. In most cases they came into the country when it was new and either acquired their lands from the Government as homesteads or purchased them cheaply from other settlers who had thus obtained them. A large part of their present wealth, therefore, has not been made off the land itself, but on the natural increase of land values, which have steadily increased from a few dollars to about $35 an acre at the present time, with a probability of still higher value in the future.

A very few of the farms are owned by persons who spend no part of the year in North Dakota, but leave their property in the hands of agents for speculative purposes or rent them for cash or on shares to farming tenants.

Most of the farms originally contained 160 acres, although a few were as large as 480 acres. The large farms were generally acquired by purchasing from railroad corporations the odd numbered alternate

sections given to them by the Government as a subsidy to foster their early enterprise. In order to form a compact tract the intervening portions were often purchased from settlers, so that at present the size of holdings ranges from 80 to 20,000 acres. The largest two holdings in the county are one at Casselton, containing 13,000 acres, and another at Amenia, containing 20,000 acres. The former is operated as a single farm, while the latter is owned by a company and leased on shares to tenants, no single tenant being permitted to work more than one section. In the vicinity of Fargo and Casselton the farms are larger than around Wheatland, and the average size of the farms throughout this area is about 600 acres.

As a rule the present land values of the area are on a legitimate basis. In a few localities where the drainage is very imperfect the land values are a little higher than the present conditions would seem to warrant, but on the whole there is bound to be a healthy increase upon the present basis. Some of the best farms are mortgaged, but these mortgages are held by local investors. In this portion of the Northwest farm mortgages indicate prosperity rather than adversity. The farms that a score or more years ago were too large for the poor farmer with his large family of small children are now too small for the grown-up boys. The family spreads and the boys marry and buy adjoining farms. The father gives them a start with a few hundred dollars, to which they add their own savings. A part is paid down for the farm and a mortgage is given for the remainder, and in the majority of cases with care and industry it is only a few years before the boys have clear titles to their farms.

The question of labor is one that is continually causing dissatisfaction among those who are operating large farms. One reason is that the poor man of enterprise and push will not remain a day laborer long because of the opportunity of his getting land and starting a home of his own. Men with enough money to make a small payment and sufficient stock and machinery to start work have been known to pay for a half section of land in two years. At the present time men of no money or stock and machinery, but with a reputation for honesty and industry, usually have no trouble in obtaining a farm with buildings, stock, and machinery, and are given plenty of time in which to pay for them. The usual method is by "crop payments," giving one-half the crop each year until the indebtedness is canceled. Upon such terms with ordinary seasons and industry a man with one or two boys old enough to work can get clear title to a half section in less than ten years, provided the farm is located upon such types as the Miami black clay loam or the Miami loam. By a process of natural selection these conditions have left as laborers a class of unmarried men who are usually rather undesirable. In the winter they divide their time between the great cities and the lumber camps of the Middle West;

in seeding and harvest time they migrate to the grain-growing communities and demand exorbitant wages. The farmer who has to hire is at their mercy and must pay at least $2.50 a day for common labor, besides furnishing board and lodging. It is often impossible to obtain help at $3 a day. Upon the whole, the present dissatisfaction with labor is having a salutary effect upon the country, and matters are gradually adjusting themselves. Farming on a large scale is declining, because of the lower prices for grain, the inefficiency of labor, and the high wages demanded by it. The large farms are being cut up to furnish homes for the many, farming is becoming more diversified, and better methods of cultivation are being introduced.

Wheat, flax, barley, and oats have been and are the chief products of the region. The heavy loamy and clay soils of the valley are recognized as being especially adapted to these crops, and the seasons are favorable. Formerly it was believed that the seasons were too short for corn, but a variety has been acclimated to the region and now thousands of acres of it are grown yearly. Corn and barley are being grown more and more every year, and hogs are being raised. This is an industry which is becoming important. Last year many carloads of hogs were shipped out of the Red River Valley to the Minneapolis, St. Paul, and Chicago markets.

The transportation facilities of the area are very good, the main line of the Northern Pacific passing through its entire length from east to west. A branch of this road, known as the Fargo and Southwestern, runs from Fargo to Lisbon, crossing the southeastern part of the area. The main line of the Great Northern crosses the area at Fargo and a branch of that line crosses at Casselton. Along these roads at intervals of about 5 miles are sidetracks with platforms, and at many of these shipping points there are elevators for storing grain. Many farmers load their grain directly into cars from the platforms, while some store it in the elevators to await future shipment.

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SOIL MAP
NORTH DAKOTA
FARGO SHEET

COOPERATING WITH THE AGRICULTURAL
AND ECONOMIC SURVEY OF NORTH DAKOTA
DANIEL E. WILLARD, DIRECTOR

Soils Surveyed by
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Field Operations
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1903